CLAIMS

We claim:

1. A process for pyrolyzing tire shreds, comprising:

(a) feeding tire shreds to a pyrolysis reactor;

(b) pyrolyzing the tire shreds in a pyrolysis reactor to produce a gas stream comprising hydrocarbon and a solid comprising carbon;

(c) removing the solid comprising carbon from the pyrolysis reactor;

(d) directing the gas stream comprising hydrocarbon into a separator;

(e) contacting the gas stream comprising hydrocarbon with an oil spray in the separator thereby washing particulate from the gas stream and condensing a portion of the gas stream to oil;

(f) removing and cooling the oil from the separator;

(g) directing non-condensed gas from the gas stream comprising hydrocarbon away from the separator; and

(h) directing a portion of the cooled oil removed from the separator to an inlet of the separator for use as the oil spray in the separator.

2. The process according to claim 1, further comprising directing the solid comprising carbon removed from the pyrolysis reactor to an auger having an inlet and an outlet and a pressure in the auger which is greater than a pressure in the pyrolysis reactor.

3. The process according to claim 2, wherein the pressure within the auger is greater than atmospheric pressure.

4. The process according to claim 2, further comprising:

(i) directing a portion of the non-condensed gas from the gas stream after step (g) to at least one burner in heat exchange relation with the pyrolysis reactor;

(ii) burning the non-condensed gas from the gas stream in the at least one burner to heat the pyrolysis reactor and thereby generating an effluent flue gas;

(iii) extracting a portion of the effluent flue gas;

(iv) cooling the extracted portion of the effluent flue gas; and

(v) injecting the cooled portion of the effluent flue gas into the auger.

5. The process according to claim 2, further comprising maintaining the auger substantially anaerobic.

6. The process according to claim 2, further comprising directing the solid comprising carbon from the outlet of the auger to a carbon black separation system to separate carbon black from the solid comprising carbon.

7. The process according to claim 6, further comprising maintaining a pressure in the carbon black separation system lower than the pressure in the auger and higher than the pressure in the pyrolysis reactor.

8. The process according to claim 7, further comprising maintaining the pressure in the auger at greater than atmospheric pressure and maintaining the pressure in the pyrolysis reactor at less than atmospheric pressure.

9. The process according to claim 1, wherein the non-condensed gas from the separator is directed to a condenser and gas leaving the condenser is directed to a flare.

10. The process according to claim 1, wherein step (f) further comprises passing the oil removed from the separator through a sludge processing system to remove sludge comprising solids and heavy oils and pulverize the solids in the sludge.

11. The process according to claim 1, wherein step (d) further comprises directing the gas stream comprising hydrocarbon through an expansion tank in communication with the separator before directing the gas stream comprising hydrocarbon into the separator and preventing accumulation of solids in the expansion tank.

12. The process according to claim 11, further comprising preventing accumulation of solids in the expansion tank using at least one paddle.

13. A process for pyrolyzing tire shreds, comprising:

(a) feeding tire shreds to a pyrolysis reactor;

(b) pyrolyzing the tire shreds in a pyrolysis reactor to produce a gas stream comprising hydrocarbon and a solid comprising carbon;

(c) removing the solid comprising carbon from the pyrolysis reactor;

(d) directing the gas stream comprising hydrocarbon from the pyrolysis reactor to a separator for condensing a portion of the gas stream comprising hydrocarbon;

(e) directing the solid comprising carbon removed from the pyrolysis reactor into an auger having a pressure in the auger which is greater than a pressure in the pyrolysis reactor;

(f) directing a portion of non-condensed gas from the gas stream after step (d) to at least one burner in heat exchange relation with the pyrolysis reactor;

(g) burning the non-condensed gas from the gas stream in the at least one burner to heat the pyrolysis reactor and thereby generating an effluent flue gas;

(h) extracting a portion of the effluent flue gas;

(i) cooling the extracted portion of the effluent flue gas; and

(j) injecting the cooled portion of the effluent flue gas into the auger.

14. The process according to claim 13, further comprising

(i) contacting the gas stream comprising hydrocarbon with an oil spray in the separator thereby washing particulate from the gas stream and condensing a portion of the gas stream to oil;

(ii) removing and cooling the oil from the separator; and

(iii) directing a portion of the cooled oil removed from the separator to an inlet of the separator for use as the oil spray in the separator.

15. The process according to claim 13, further comprising maintaining the auger substantially anaerobic.

16. The process according to claim 13, further comprising directing the solid comprising carbon from the outlet of the auger to a carbon black separation system for separating carbon black from the solid comprising carbon.

17. The process according to claim 16, further comprising maintaining a pressure in the carbon black separation system lower than the pressure in the auger and higher than the pressure in the pyrolysis reactor.

18. The process according to claim 13, further comprising maintaining the pressure in the auger at greater than atmospheric pressure and maintaining the pressure in the pyrolysis reactor at less than atmospheric pressure.

19. A tire pyrolysis system, comprising:

(a) a pyrolysis reactor having a tire shreds inlet, a solids removal outlet and a gas stream removal outlet;

(b) at least one heating element in heat exchange relation with the pyrolysis reactor;

(c) a separator having a gas stream inlet in communication with the gas stream removal outlet of the pyrolysis reactor, a liquid outlet, at least one oil sprayer having a sprayer inlet in an upper portion of the separator and a non-condensed gas outlet; and

(d) an auger having an inlet and an outlet, the inlet of the auger being in communication with the solids removal outlet of the pyrolysis reactor.

20. The tire pyrolysis system according to claim 19, further comprising a tire shreds feeding mechanism in communication with the tire shreds inlet of the pyrolysis reactor.

21. The tire pyrolysis system according to claim 19, further comprising a carbon black separation system having an inlet in communication with the outlet of the auger.

22. The tire pyrolysis system according to claim 21, wherein the carbon black separation system comprises at least one carbon black separator having a carbon black outlet, and a roller mill in solids communication with the carbon black outlet of the at least one carbon black separator.

23. The tire pyrolysis system according to claim 22, wherein the carbon black separation system further comprises a screener and a bagging system in solids communication with the roller mill.

24. The tire pyrolysis system according to claim 19, wherein the carbon black separation system comprises at least one trough auger.

25. The tire pyrolysis system according to claim 24, wherein the at least one trough auger in the carbon black separation system has a flighting having projections extending from the flighting to enhance tumbling action and agglomeration of small fiberglass particles.

26. The tire pyrolysis system according to claim 19, wherein the auger is a trough auger.

27. The tire pyrolysis system according to claim19, wherein the pyrolysis reactor is a continuous pyrolysis reactor.

28. The tire pyrolysis system according to claim 27, wherein the pyrolysis reactor comprises a pin auger.

29. The tire pyrolysis system according to claim 19, wherein the solids removal outlet of the pyrolysis reactor comprises a flexible assembly which is capable of compensating for thermal expansion of the reactor during pyrolysis.

30. The tire pyrolysis system according to claim 29, wherein the flexible assembly comprises a trolley adjustably suspended by a support structure, the trolley being connected by a cable to the solids removal outlet of the pyrolysis reactor.

31. The tire pyrolysis system according to claim 19, further comprising airlocks at the tire shreds inlet and the solids removal outlet of the pyrolysis reactor and at the inlet and outlet of the auger.

32. The tire pyrolysis system according to claim 31, wherein the movement of the airlocks is timed.

33. The tire pyrolysis system according to claim 19, wherein the at least one heating element is at least one burner having a gas inlet and an effluent gas outlet, the gas inlet being in communication with the non-condensed gas outlet of the separator.

34. The tire pyrolysis system according to claim 33, wherein the effluent gas outlet of the at least one burner is in fluid communication with an inlet of a heat exchanger for cooling effluent gas from the at least one burner and the heat exchanger has an outlet in fluid communication with the auger such that cooled effluent gas can be injected into the auger.

35. The tire pyrolysis system according to claim 19, wherein the sprayer inlet is in fluid communication with the liquid outlet of the separator such that at least a portion of oil condensed in the separator may be introduced into the separator through the at least one oil sprayer.

36. The tire pyrolysis system according to claim 19, further comprising a sludge removal system having an inlet in fluid communication with the liquid outlet of the separator, a sludge outlet, a screen and one of a pulverizer or a delumper.

37. The tire pyrolysis system according to claim 19, further comprising a vent line in communication between the screen and an inlet of a condensor having an inlet which is in communication with the non-condensed gas outlet of the separator.

38. The tire pyrolysis system according to claim 37, wherein the sludge outlet of the sludge removal system is in communication with the pyrolysis reactor.

39. The tire pyrolysis system according to claim 19, further comprising a condenser having an inlet in communication with the non-condensed gas outlet of the separator and a gas outlet in communication with a flare.

40. The tire pyrolysis system according to claim 19, further comprising a condenser having an inlet in communication with the non-condensed gas outlet of the separator and a gas outlet, wherein an inlet of a pressure adjusting source is in communication with the gas outlet of the condenser and the pressure adjusting source is capable of maintaining constant reactor pressure in the pyrolysis reactor.

41. The tire pyrolysis system according to claim 40, wherein the pressure adjusting source comprises a blower having an inlet in communication with the outlet of the condenser and an outlet in communication with a gas flow control valve.

42. The tire pyrolysis system according to claim 41, wherein the gas flow control valve is a butterfly valve.

43. The tire pyrolysis system according to claim 19, further comprising an expansion tank having an inlet in communication with the gas stream removal outlet of the pyrolysis reactor and with the gas stream inlet of the separator, wherein the expansion tank comprises at least one movable paddle capable of preventing accumulation of solids in the expansion tank.

44. A tire pyrolysis system, comprising:

(a) a pyrolysis reactor having a tire shreds inlet, a solids removal outlet and a gas stream removal outlet;

(b) at least one burner in heat exchange relation with the pyrolysis reactor and having a gas inlet and an effluent gas outlet;

(c) a separator having a gas stream inlet in communication with the gas stream removal outlet of the pyrolysis reactor, a liquid outlet, and a non-condensed gas outlet in communication with the gas inlet of the at least one burner; and

(d) an auger having an inlet and an outlet, the inlet of the auger being in communication with the solids removal outlet of the pyrolysis reactor, wherein the effluent gas outlet of the at least one burner is in fluid communication with an inlet of a heat exchanger for cooling effluent gas from the at least one burner and the heat exchanger has an outlet in fluid communication with the auger such that cooled effluent gas can be injected into the auger.

45. The tire pyrolysis system according to claim 44, wherein the auger is a trough auger.

46. The tire pyrolysis system according to claim 44, wherein the separator further comprises an oil sprayer.